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(54) **Complexes of bivalent copper, methods of preparation thereof and compositions containing said complexes.**

(57) Neutral copper complexes, particularly copper-salicylate complexes having the formula $Cu[C_6H_4(OH)COO]_2$ ROH in which ROH represents an alkanol, have been found to have therapeutic activity in the treatment of inflammatory diseases. The complexes have been found particularly suitable for the treatment of arthritis.

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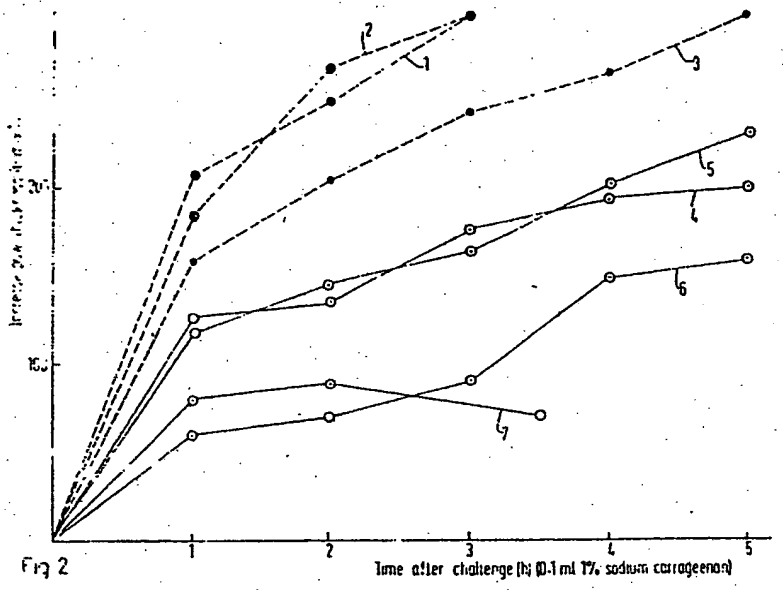
1
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Time after challenge (h) (0.1 ml 1% sodium carrageenan)

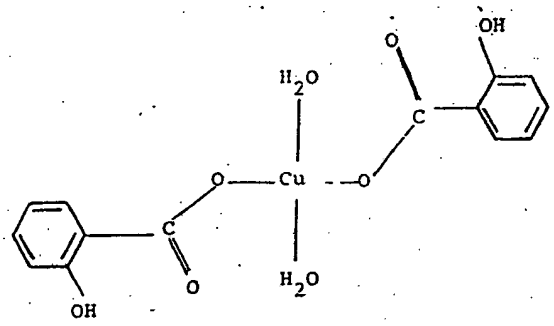
Fig 2

COMPLEXES OF BIVALENT COPPER, METHODS OF PREPARATION THEREOF AND COMPOSITIONS CONTAINING SAID COMPLEXES

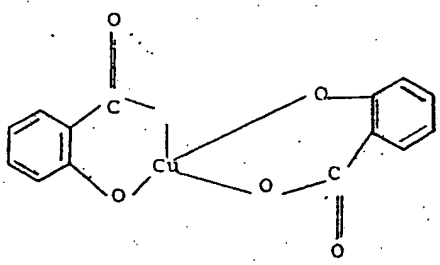
This invention relates to novel anti-inflammatory copper complexes and to anti-inflammatory compositions and processes utilizing such complexes.

Many studies of the role of copper, and especially complexes of copper, in the treatment of inflammatory diseases have been reported in recent years. One of the most recent studies describes the use of parenterally administered copper complexes, and particularly copper (II) salicylate, in the treatment of rheumatic disease (Sorenson and Hangarter, Inflammation, 2, 217-238 (1977)).

The prior art describes a wide variety of copper-salicylate complexes prepared by the reaction of inorganic copper (II) salts with salicylic acid in aqueous solution. The specific complex formed in aqueous solution has been found to depend on the pH of the aqueous solution and both neutral complexes such as the pale blue crystalline bis (salicylato) copper (II) tetrahydrate



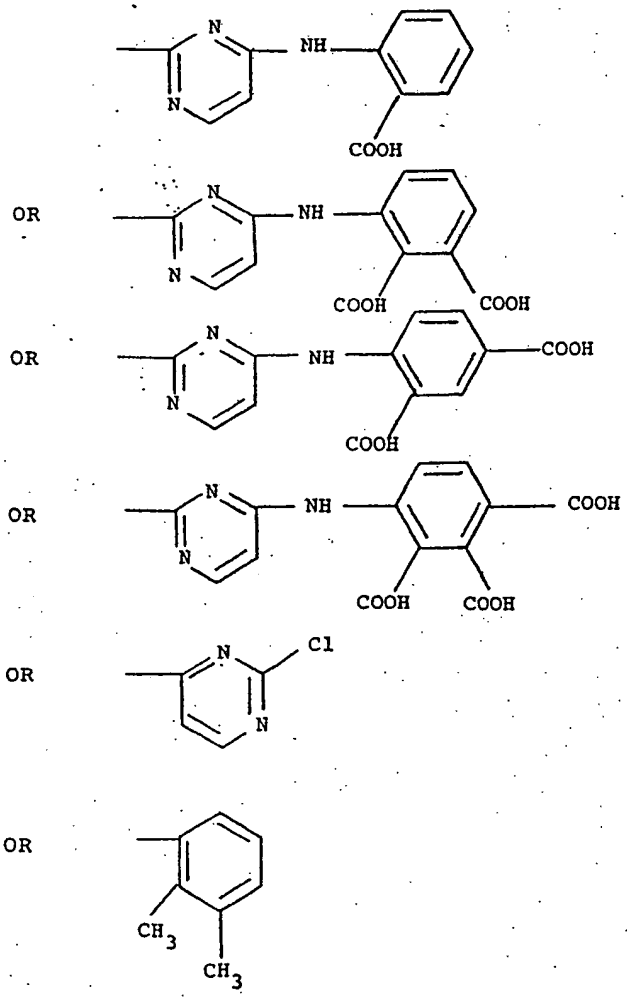
and anionic complexes such as the olive green sodium salicylatocuprate (II)



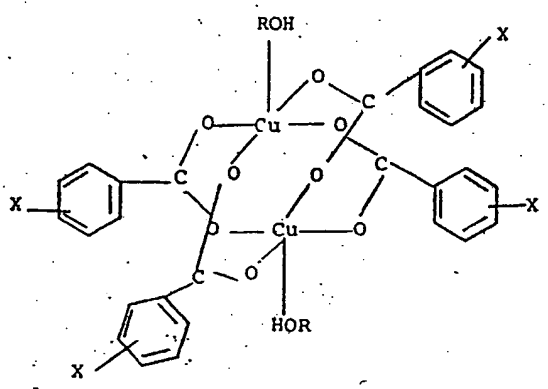
are known in the art.

It is an object of this invention to provide novel neutral copper complexes prepared by the reaction of copper compounds and substituted benzoic acids in non-aqueous solvents. A further object of the invention is to provide a method for the treatment of inflammatory diseases of animals by the administration of compositions comprising as active ingredient the novel copper complexes of the invention.

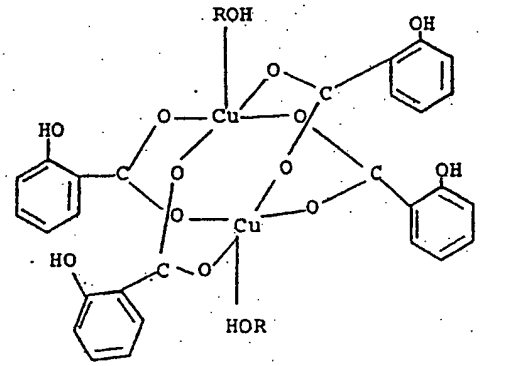
Accordingly in one embodiment the invention provides neutral copper complexes of the formula $Cu[C_6H_4(X)COO]_2$ ROH wherein ROH represents an alkanol, preferably a C_1 to C_6 aliphatic alkanol, and wherein X can be located in any position and is OH, SH, SeH, NH_2 or NHR where R is



Although in no way wishing to be bound by theory, as a result of physico-chemical studies the complexes of the invention are believed to have the following dimeric structure:



The preferred compound according to the invention is the copper salicylate complex which is believed to have the formula:



(II)

The compounds of the invention may be prepared by reacting inorganic copper (II) compounds, for example copper salts or cupric hydroxide, with the appropriate substituted benzoic acid in the presence of an alkanol. For example, reaction of cupric hydroxide with salicylic acid in anhydrous ethanol gives the complex of formula $Cu[C_6H_4(OH)COO]_2 \cdot C_2H_5OH$, hereinafter referred to by the formula $Cu[H\ Sal]_2 \cdot C_2H_5OH$, which forms deep green crystals when crystallised from anhydrous ethanol containing excess (approx. 5M) salicylic acid.

The compounds of the invention have been found to be particularly useful in the treatment of inflammatory diseases in animals. Thus in a further embodiment the invention provides a process for the treatment of inflammatory diseases of animals which process comprises administering to said animals an effective amount of a compound of the invention as hereinbefore defined.

The compounds of the invention have proved particularly effective in alleviating the symptoms of inflammatory diseases such as rheumatic disease, arthritis and rheumatoid arthritis when applied topically to the animal.

Preferably the compounds of the invention are applied in the form of a composition comprising a compound of the invention in admixture with a pharmaceutically acceptable carrier. Therefore, in yet a further aspect the invention provides pharmaceutical anti-inflammatory compositions comprising a compound of the invention as hereinbefore defined and a pharmaceutically acceptable carrier therefor.

The compositions are preferably suitable for topical application to animals to be treated and therefore may be in the form of a gel, an ointment, a paste, a cream or a lotion. Compositions comprising a compound of the invention in solution are preferred as

they are more efficient in perfusing the skin.

The compounds of the invention have limited stability in the presence of water and therefore the compositions preferably comprise a non-aqueous carrier. More preferred compositions comprise a compound of the invention dissolved in a non-aqueous lipophilic carrier. Suitable carriers include monohydric, dihydric and trihydric alkanols such as, for example: short chain (C_1 to C_{10}) and long chain C_{12} to C_{20} alcohols including methanol, ethanol, propanol, butanol and cetyl alcohol; dihydric alcohols such as diethylene glycol; and polyhydric alcohols such as glycerol.

Even more preferred compositions which have been shown to have an indefinite shelf life, comprise a compound of the invention in solution in a liquid carrier comprising an alkanol, glycerol and salicylic acid.

The amount of the compound of the invention employed in the compositions will depend to a large extent on the inflammatory condition being treated. However, as a general rule the compositions may comprise from 0.1 to 15% w/v of the copper compounds of the invention and preferably from 1 to 7% w/v.

As previously indicated the compounds of the invention have proved particularly useful in the alleviation of the symptoms of inflammatory disease when applied topically to the animal in the form of a pharmaceutical composition as hereinbefore defined. The compounds are believed to be efficacious in such treatments because of their ready penetration of the skin. Furthermore, the compounds are believed to offer particular advantages in the treatment of inflammatory diseases of humans because of the non-toxic nature of the compounds and evidence that the compounds are readily cleared from the treated animal as indicated by the limited duration of the anti-inflammatory effect of.

the compounds.

The compositions may comprise, in addition to one or more compounds of the invention, other pharmaceutically active ingredients including other anti-inflammatory agents and conventional pharmaceutical excipients known in the art.

The invention is now illustrated by but not limited to the following examples.

EXAMPLE 1

Preparation of Cu/H Sal7$_2$. C_2H_5OH.

Freshly prepared $Cu(OH)_2$ (0.97 g) was added to a solution of salicylic acid (6.9 g) in anhydrous ethanol (50 ml). The suspension was then refluxed on a water bath until all the copper hydroxide had reacted. The resultant deep-green-coloured solution was then filtered and green crystals were deposited on cooling. These were filtered off, washed with cold alcohol and air dried. Yield 3.2 g (Found: Cu, 16.6; C, 50.2; H, 4.2; $CuC_{16}H_{16}O_7$ requires Cu, 16.6; C, 50.1; H, 4.2%.)

EXAMPLE 2

Preparation of Cu/H Sal7$_2$. CH_3OH and Cu/H Sal7$_2$. C_3H_7OH.

Cu /H Sal7$_2$. CH_3OH, analysed as Cu $C_{15}H_{14}O_7$, and Cu /H Sal7$_2$. C_3H_7OH, analysed as Cu $C_{17}H_{18}O_7$, were prepared following the procedure described in Example 1 and substituting for anhydrous ethanol, anhydrous methanol and anhydrous n-propanol respectively.

EXAMPLE 3

This Example demonstrates the preparation of a composition comprising Cu/H Sal7$_2$. C_2H_5OH.

Freshly prepared cupric hydroxide (1.0 g) was added to a solution of salicylic acid (7 g) in anhydrous ethanol (80 ml). The suspension was heated under reflux until all the cupric hydroxide had reacted. The resultant deep-green-coloured solution was filtered to remove any insoluble polymeric copper salicylate and glycerol (20 ml) was added to the filtrate.

The deep-green c. 0.1 M Cu /H Sal7$_2$. C_2H_5OH solution obtained by this procedure was found to be stable for a prolonged indefinite period and was used in the tests described in Examples 4 and 5.

EXAMPLE 4

This example demonstrates the percutaneous absorption of the compound $Cu[H\ Sal]_2 . C_2H_5OH$.

Male Wistar rats (average weight 250 g) were anaesthetised with diethyl ether and an area of c 20 sq. cm. was shaven high on their backs. The $Cu[H\ Sal]_2 . C_2H_5OH$ composition prepared according to example 3 was then applied to each rat (c. 20 ml per 3 rats). The rats were then returned to their cages and after two days their urine was collected and compared with the urine of control, untreated, rats following the procedure below.

Urine (5 ml) was acidified with 2M H_2SO_4 and shaken with ethyl acetate (2 ml). After centrifuging the ethyl acetate layer was analysed by thin layer chromatography on silica gel (solvent: benzene, diethyl ether; glacial acetic acid; methanol; 120:60:18:1 by volume) along with samples of salicylic acid, salicyluric acid, gentisic acid and ethyl salicylate.

The results are shown in Figure 1 which is a diagrammatic representation of a chromatogram run under the conditions described above with solvent flow from origin line, represented by the points of application of the samples 1 to 9, in the direction of the arrow shown and wherein:

1 and 9 represent the points of application of a sample of a mixture of salicyluric acid (a) and salicyclic acid (b) chromatographed for comparative purposes;

2 and 8 represent the points of application of a sample of the urine extract of rats treated with the $Cu H[Sal]_2 . C_2H_5OH$ composition;

3 and 7 represent the points of application of a sample of the urine extract of control, untreated, rats;

4 and 6 represent the points of application of a

sample of a mixture of gentisic acid (c) and ethyl salicylate (b) chromatographed for comparative purposes; and

5 represents the point of application of a sample of the $Cu[H\ Sal]_2 . C_2H_5OH$ composition used to treat the rats.

The chromatogram clearly shows the presence of salicylic acid and gentisic acid in the urine of the $Cu[H\ Sal]_2 . C_2H_5OH$ treated rats indicating that the composition has perfused the skin of the rats.

EXAMPLE 5

This example demonstrates the effectiveness of topical application of the compound $Cu(H\ Sal)_2 . C_2H_5OH$ in alleviating the symptoms of artificially induced inflammation in rats.

Male Wistar rats (average weight 250 g) were anaesthetised with diethyl ether and an area of c. 20 sq. cm was shaven high on their backs. The rats were then separated into 7 groups. Group 1, the control rats were not treated. Group 2 rats were treated by the application of a mixture of alcohol and glycerol (4:1) the carrier used for the compound $Cu(H\ Sal)_2 . C_2H_5OH$. Group 3 rats were treated with a 7% w/v solution of salicylic acid in a mixture of alcohol and glycerol (4:1). Group 4, 5, 6 and 7 rats were treated with amounts of $Cu(H\ Sal)_2 . C_2H_5OH$ composition prepared according to example 3 containing 154 mg, 231 mg, 462 mg and 770 mg respectively of $Cu(H\ Sal)_2 . C_2H_5OH$.

About 6 hours after the topical treatment of the rats inflammation was induced in a foot of each rat in each of the groups by the injection of 0.1 ml of 1% saline solution of sodium carrageenan into a foot pad of each rat. The inflammation of the feet of the rats in each group was then monitored by the swelling of the feet with a micrometer screw-gauge.

The results are shown in Figure 2 wherein the curves represent the increase in paw thickness of the rats with time after the injection of the inflammatory agent. The curves 1 to 7 represent the swelling of the paws of the rats of groups 1 to 7 respectively.

Figure 2 clearly shows the anti-inflammatory effect of the topically applied compound $Cu(Hsal)_2 \cdot C_2H_5OH$.

EXAMPLE 6

Preparation of $Cu(C_6H_4(SH)COO)_2 \cdot C_2H_5OH$.

This compound was prepared as described in Example 1, but substituting 2-thiobenzoic acid (7.7 g) for the salicylic acid. Yield 2.9 g. (Found: Cu 15.6; C 45.9; H 3.6. $CuC_{16}H_{16}O_5S_2$ requires Cu 15.4; C 46.2; H 3.9%).

EXAMPLE 7

Preparation of $Cu(C_6H_4(SbH)COO)_2 \cdot C_2H_5OH$.

This compound was prepared as described in Example 1, but substituting 2-selenibenzoic acid (10.0 g) for the salicylic acid. Yield 8.1 g. (Found: Cu 12.3; C 38.1; H 3.5. $CuC_{16}H_{16}O_5Se_2$ requires Cu 12.6; C 37.7; H 3.1%).

EXAMPLE 8

Preparation of $Cu(C_6H_4(NH_2)COO)_2 \cdot C_2H_5OH$.

This compound was prepared as described in Example 1, but substituting 2-aminobenzoic acid (6.9 g) for the salicylic acid. Yield 5.6 g. (Found: Cu 16.4; C 50.6; H 5.0. $CuC_{16}H_{18}O_5N_2$ requires Cu 16.8; C 50.3; H 4.7%).

EXAMPLE 9

Preparation of $Cu_2(C_6H_4 \cdot CO_2 \cdot NH \cdot C_4N_2H_2 \cdot NH \cdot C_7H_4O_2)_2 \cdot C_2H_5OH$.

This compound was prepared as described in Example 1, but substituting 2-(2-carboxyphenyl)amino-4-(2-carboxyphenyl) amino-pyrimidine (16.8 g) for salicylic

acid. Yield 13.3 g. (Found: Cu 24.5; C 46.2; H 3.2. $Cu_2C_{20}H_{18}O_5N_4$ requires Cu 24.5; C 46.0; H 3.5%).

EXAMPLE 10

Preparation of $Cu_2[C_6H_4.CO_2.NH.C_4N_2H_2.NH.C_8H_4O_4].C_2H_5OH$.

This compound was prepared as described in Example 1, but substituting 2-[2-carboxyphenyl]amino-4-[2,3-dicarboxyphenyl]amino-pyrimidine (19.0 g) for the salicylic acid. Yield 14.0 g. (Found: Cu 22.4; C 44.7; H 3.3. $Cu_2C_{21}H_{18}O_7N_4$ requires Cu 22.6; C 44.5; H 3.2%).

EXAMPLE 11

Preparation of $Cu_2[C_6H_4.CO_2.NH.C_4N_2H_2.NH.C_8H_4O_4].C_2H_5OH$.

This compound was prepared as described in Example 1, but substituting 2-[2-carboxyphenyl]amino-4-[2,4-dicarboxyphenyl]amino-pyrimidine (19.0 g) for the salicylic acid. Yield 15.3 g. (Found: Cu 24.7; C 45.8; H 3.7. $Cu_2C_{21}H_{18}O_7N_4$ requires Cu 24.5; C 46.0; H 3.5%).

EXAMPLE 12

Preparation of $Cu[C_6H_4.CO_2.C_4N_2H_2Cl]_2.C_2H_5OH$.

This compound was prepared as described in Example 1, but substituting 4-(2-carboxyphenyl)amino-2-chloro-pyrimidine (11.7 g) for the salicylic acid. Yield 9.5 g. (Found: Cu 12.5; C 56.5; H 3.9. $CuC_{24}H_{18}O_5N_4$ requires Cu 12.7; C 56.9; H 3.6%).

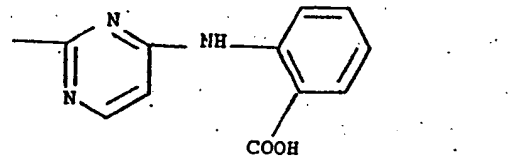
EXAMPLE 13

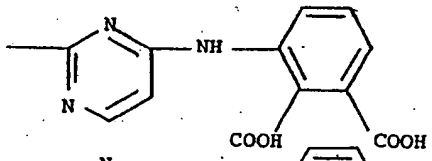
Preparation of $Cu[C_6H_4.CO_2.NH.C_8H_9]_2.C_2H_5OH$.

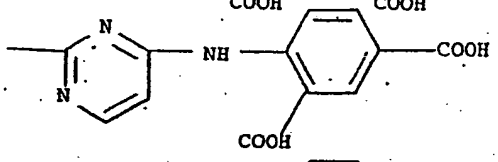
This compound was prepared as described in Example 1, but substituting 2-[2,3-dimethylphenyl]aminobenzoic acid (6.8 g) for the salicylic acid. Yield 5.5 g. (Found: Cu 11.2; C 64.9; H 5.5. $CuC_{32}H_{34}O_5N_2$ requires Cu 10.9; C 65.1; H 5.8%).

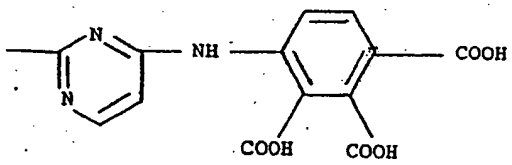
CLAIMS:

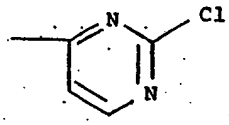
1. Neutral copper complexes characterized in that they have the formula $Cu[C_6H_4(X)COO]_2$ ROH wherein ROH represents an alkanol, and wherein X can be located in any position and is OH, SH, SeH, NH_2 or NHR where R is

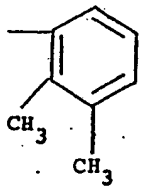






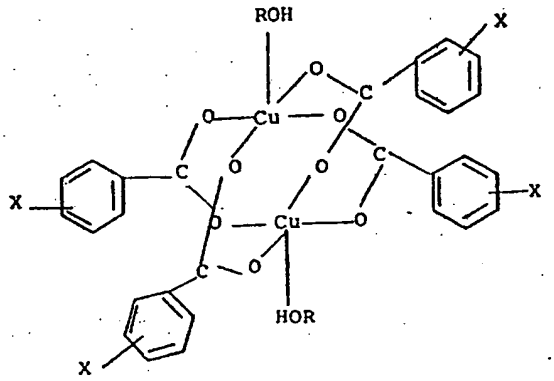






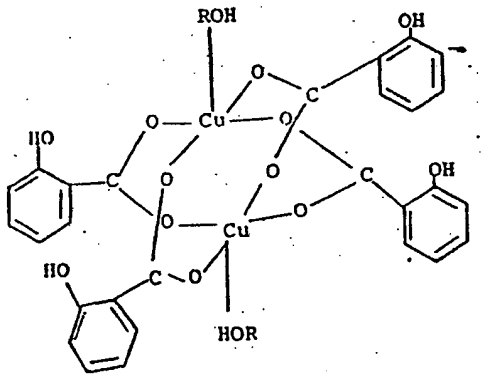
2. Complexes according to claim 1 characterized in that the alkanol is a C_1 to C_6 aliphatic alkanol.

3. Complexes according to claim 1 or claim 2 characterized in that they have the formula



4. Ccmplexes according to any one of claims 1 to 3 characterized in that X is OH.

5. Complexes according to claim 3 characterized in that they have the formula



(II)

6. A method of preparing complexes as claimed in any of claims 1 to 5 characterized in that it comprises reacting an inorganic copper (II) compound with a substituted benzoic acid in the presence of an alkanol.

7. A method according to claim 6 characterized in that the substituted benzoic acid is salicylic acid.

8. A method according to claim 6 or claim 7, characterized in that the copper (II) compound is a salt or cupric hydroxide.

9. A method according to any one of claims 6 to 8, characterized in that the alkanol is a C_1 to C_6 aliphatic alkanol.

10. A pharmaceutical composition characterized in that it comprises a compound according to any one of claims 1 to 5 and a pharmaceutically acceptable carrier.

11. A composition according to claim 10, characterized in that the pharmaceutically acceptable carrier is a non-aqueous carrier.

12. A composition according to claim 11, characterized in that the carrier comprises an alkanol, glycerol and salicylic acid.

13. A composition according to any one of claims 10 to 12 characterized in that it contains 0.1 to 15% w/v, preferably 1 - 7% w/v, of active ingredient.

14. A method of treating inflammatory diseases characterized in that it comprises administering to the patient an effective amount of a composition as claimed in any one of claims 1 to 5 and 10 to 13.

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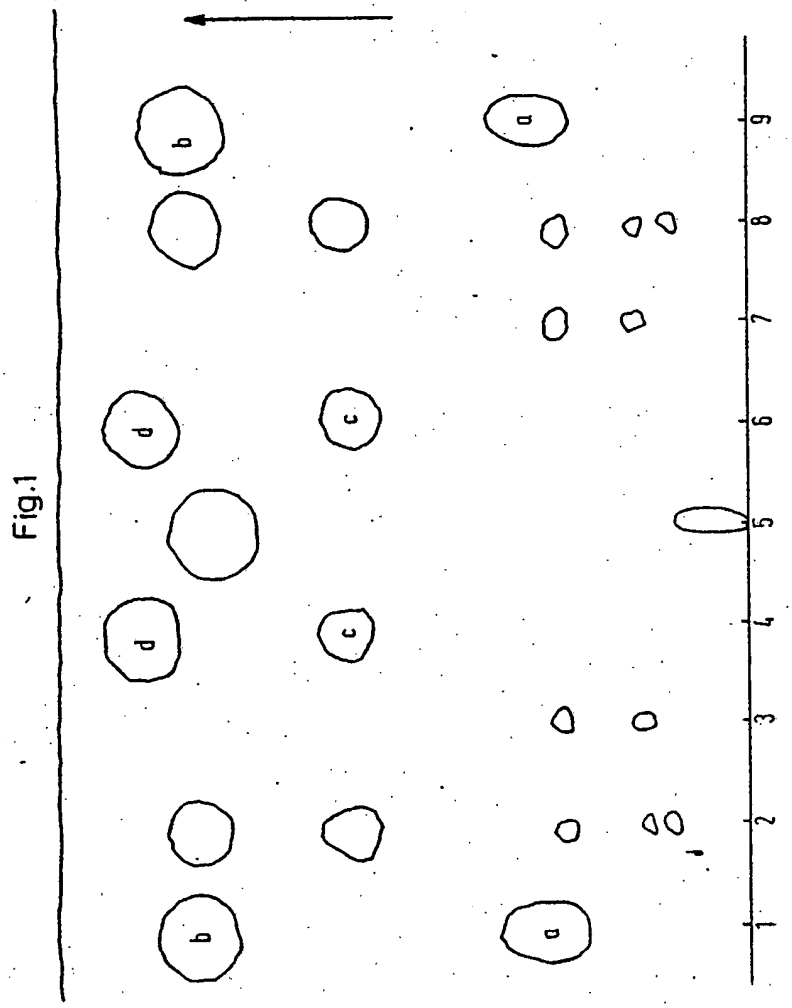

Fig.1

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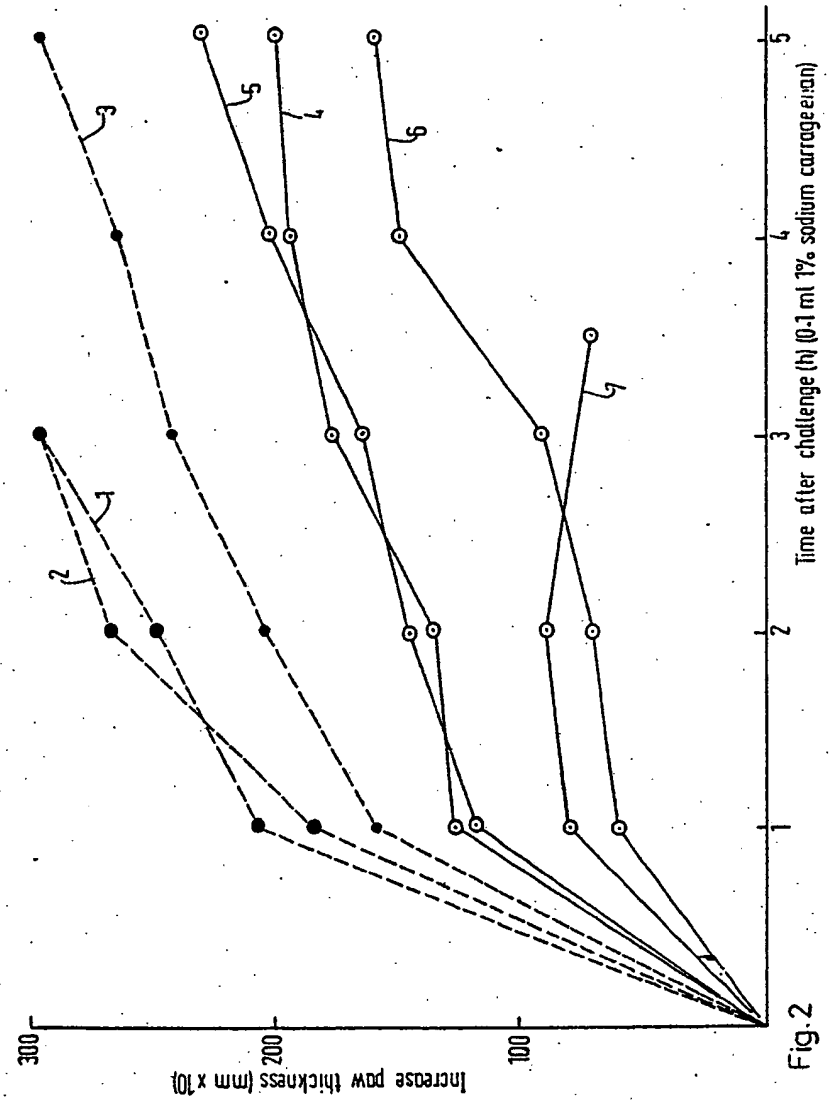

Fig.2

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 78 300 671.1

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.²)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	US - A - 3 884 949 (H. EICKE et al) * claim 1 *	1	C 07 C 65/10 C 07 C 101/50 C 07 C 101/52 C 07 C 101/54 C 07 C 101/56 C 07 C 101/60 C 07 C 149/40 C 07 C 163/00 C 07 D 239/42 C 07 D 239/48
X	Chemical Abstracts vol. 73, no. 22, 1970 Columbus, Ohio, USA O. HULKOVA et al "Binding of binuclear copper (II)-salicylate and copper (II)-2.3-cresotate complexes" page 461, abstract no. 115 882p & Acta Fac. Pharm., Univ. Comeniana vol. 17, 1969, pages 73 to 77	1-9	TECHNICAL FIELDS SEARCHED (Int.Cl.²) C 07 C 65/10 C 07 C 101/50 C 07 C 101/52 C 07 C 101/54 C 07 C 101/56 C 07 C 101/60 C 07 C 149/40 C 07 C 163/00 C 07 D 239/42 C 07 D 239/48
X	Chemical Abstracts vol. 69, no. 25, 1968 Columbus, Ohio, USA J. KRATSMAR SMOGRAVIC et al "Copper (II) salicylate and o-cresotate complexes with ethanol" page 10 573, abstract no. 113 013z & Chem. Zvesti, vol. 22, no. 7, 1968, pages 493 to 501	1-9	CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons

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&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	27-02-1979	KNAACK

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	Chemical Abstracts vol. 84, no. 7, 1976 Columbus, Ohio, USA J.R.J. SORENSON "Copper chelates as possible active forms of the antiarthritic agents" pages 14 to 15, abstract no. 38 591r & J. Med. Chem. vol. 19, no. 1, 1976, pages 135 to 148 --	14	
A	Chemical Abstracts vol. 84, no. 23, 1976 Columbus, Ohio, USA J.R.J. SORENSON "The anti-inflammatory activity of some copper chelates" page 31, abstract no. 159 685f & Trace Subst. Environ. Health vol. 8 1974, pages 305 to 311 --	14	TECHNICAL FIELDS SEARCHED (Int. Cl.²)

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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.²)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	Chemical Abstracts vol. 85, no. 17 1976 Columbus, Ohio, USA J.R.J. SORENSON "Some copper coordination compounds and their antiinflammatory and antiulcer activities" page 40, abstract no. 116 777t & Inflammation (N.Y.) vol. 1, no. 3, 1976, pages 317 to 331 ----	14	TECHNICAL FIELDS SEARCHED (Int. Cl.²)